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O T T A W A August 19th, 1943.

R E P O R T

of the

ORE DRESSING AND METALLURGICAL LABORATORIES.

Investigation No. 1479.

Examination of Aluminium Alloy Rivets Suspected
of Having Been Overheated.

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DATE 08-11-2008 BY 60322 UCBAW/STP/STP

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**Examination of Aluminium Alloy Rivets Suspected
of Having Been Overheated.**

Origin of Samples and Object of Investigation:

Seven batches of samples of aluminium alloy rivets were submitted (letter, File No. 902-38-1, AMAE DAI) on August 6th, 1943, by Air Commodore A. L. Johnson, for Chief of Air Staff, Department of National Defence, Air Service, Ottawa, Ontario.

The boxes containing the samples were numbered as follows:

(Continued on next page)

(Origin of Samples and Object of Investigation, cont'd) -

- Box No. 1. - AN 430 - AD-5-5. Millen's stock, 165 $\frac{5}{8}$ pounds received on Stowell's release. Note 5832.
- Box No. 2. - AN 430 - AD-5-16. Millen's stock, 36 pounds received on Stowell's release. Note 5828.
- Box No. 3. - AN 450 - AD 6-16. Millen's stock, 4 $\frac{1}{4}$ pounds received on Stowell's release. Note 5828.
- Box No. 4. - AN 430 - AD 5-10. Millen's stock, 27 pounds received on Stowell's release. Note 5828.
- Box No. 5. - AN 455 - AD 5-6. Millen's stock, 195 pounds received on Stowell's release. Note 5830.
- Box No. 6. - AN 430 - AD 5-7. Millen's stock, 57 pounds received on Stowell's release. Note 5828.
- Box No. 7. - AN 430 - AD 6-7. Millen's stock, 31 $\frac{1}{2}$ pounds received on Stowell's release. Note 5337.

It was requested that the samples be examined metallurgically to determine whether overheating is evident.

Macro-Examination:

Practically all rivets had been treated with a purple die. A few rivets in Boxes Nos. 1 and 7, of different size and shape from the others in their box, had light (and, in one instance, black) surfaces. This might indicate that these were made from a different alloy.

By visual examination a rivet (of the same general size and finish as the others in that box) which appeared to be porous and rough-surfaced was found in each of Boxes Nos. 1 and 7. In Box No. 7 a porous ball of metal, which was evidently a melted rivet, was seen. A very small rivet in Box No. 4, not at all comparable in size to the others in that box, also appeared to be burnt.

Physical Examination:

Hardness readings were taken on sections of the bodies of the rivets, using the Vickers method with a 10-kilogram load. Results were:

<u>Lot No.</u>	<u>V.H.N.</u>
1 (Porous rivet)	- 45.8
(Normal ")	- 76.6
2 -	- 74.5-79.2
3 -	- 78.3
4 -	- 77.6
5 -	- 76.6
6 -	- 76.8
7 (Porous rivet)	- 45.4
(Normal ")	- 72.5

Micro-Examination:

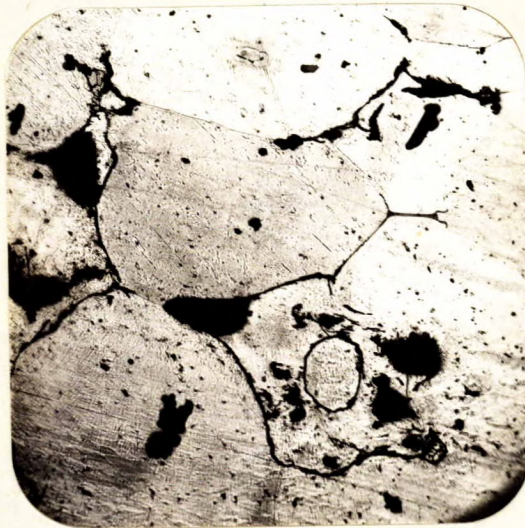
Two rivets which were considered to exhibit the roughest surface or the most irregular finish were selected from each box. Longitudinal sections from these rivets were polished and then etched with Keller's reagent (1 per cent HF, 1.5 per cent HCl, 2.5 per cent HNO₃, and 95 per cent H₂O).

The rivets from Boxes Nos. 1 and 7, described under "Macro-Examination" as having rough surfaces, were very porous and large-grained. Figure 1, a photomicrograph at 100 diameters of the rivet from Box No. 7, is typical of both. Note evidence of burning (darkly outlined grains).

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(Micro-Examination, cont'd) -

Figure 1.



X100, Keller's etch.

OVERHEATED RIVET FROM BOX NO. 7.

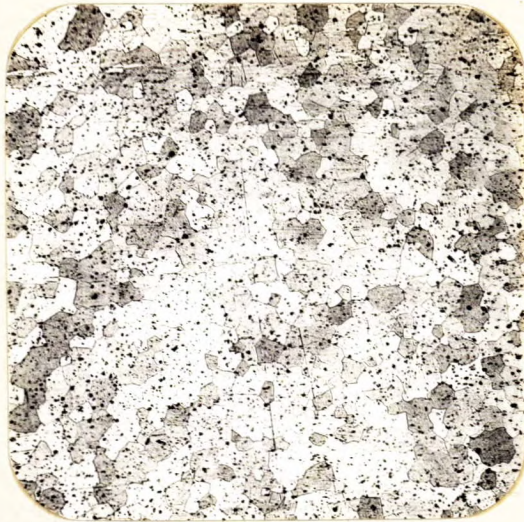
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No examination was made of the small porous rivet in Box No. 4, which was undoubtedly burnt, because its "off" size indicated that it was not typical.

The other rivets from these two boxes and from all others appeared to have been satisfactorily heat-treated. Figures 2 and 3 are photomicrographs of the head and body, respectively, of a rivet from Box No. 5. These are representative (grain sizes vary from lot to lot) of other rivets having acceptable heat treatments. The grain size of the head, in all cases, was smaller than that of the body.

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Figure 2.



X100, Keller's etch.
HEAD OF RIVET FROM BOX NO. 5.

Figure 3.



X100, Keller's etch.
BODY OF RIVET FROM BOX NO. 5.

Discussion of Results:

The burning revealed by the examination occurred as a result of heating above the liquidus temperature in the heat-treatment operation.

The smaller grain size of the heads of the rivets as compared to the bodies was undoubtedly caused by more

(Discussion of Results, cont'd) -

working of that portion during fabrication, resulting in a finer grain size on heat treatment.

CONCLUSION:

The great majority of the rivets selected for examination had been heat-treated satisfactorily, but two which had been severely overheated were found (in Boxes Nos. 1 and 7). Whether this is a cause for rejection is the responsibility of the inspection body concerned, but it is thought that the presence of the defective material is sufficient cause for rejection.

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